from adjacent trenches and over the upper surface of the sacrificial layer. The sacrificial layer is removed, for example using chemical etching process or thermal decomposition process, and regions from which the sacrificial layer has been removed form channels in the metal layer. An additional layer of the metal is deposited over the upper surfaces of the metal layer to close the gaps over the channels.

[0188] In the embodiments of the invention, reservoirs, openings and channels can be made by using soft lithography method with suitable materials, such as silicon and polydimethylsiloxane (PDMS). With these techniques it is possible to generate patterns with critical dimensions as small as 30 nm. These techniques use transparent, elastomeric PDMS "stamps" with patterned relief on the surface to generate features. The stamps can be prepared by casting prepolymers against masters patterned by conventional lithographic techniques, as well as against other masters of interest. Several different techniques are known collectively as soft lithography. They are as described below:

[0189] Near-Field Phase Shift Lithography. A transparent PDMS phase mask with relief on its surface is placed in conformal contact with a layer of photoresist. Light passing through the stamp is modulated in the near-field. Features with dimensions between 40 and 100 nm are produced in photoresist at each phase edge.

[0190] Replica Molding. A PDMS stamp is cast against a conventionally patterned master. Polyurethane is then molded against the secondary PDMS master. In this way, multiple copies can be made without damaging the original master. The technique can replicate features as small as 30 nm.

[0191] Micromolding in Capillaries (MIMIC). Continuous channels are formed when a PDMS stamp is brought into conformal contact with a solid substrate. Capillary action fills the channels with a polymer precursor. The polymer is cured and the stamp is removed. MIMIC is able to generate features down to 1 μm in size.

[0192] Microtransfer Molding ((TM). A PDMS stamp is filled with a prepolymer or ceramic precursor and placed on a substrate. The material is cured and the stamp is removed. The technique generates features as small as 250 nm and is able to generate multilayer systems.

[0193] Solvent-assisted Microcontact Molding (SAMIM). A small amount of solvent is spread on a patterned PDMS stamp and the stamp is placed on a polymer, such as photoresist. The solvent swells the polymer and causes it to expand to fill the surface relief of the stamp. Features as small as 60 nm have been produced.

[0194] Microcontact Printing ((CP). An "ink" of alkanethiols is spread on a patterned PDMS stamp. The stamp is then brought into contact with the substrate, which can range from coinage metals to oxide layers. The thiol ink is transferred to the substrate where it forms a self-assembled monolayer that can act as a resist against etching. Features as small as 300 nm have been made in this way.

[0195] Techniques used in other groups include micromachining of silicon for microelectromechanical systems, and embossing of thermoplastic with patterned quartz. Unlike conventional lithography, these techniques are able to generate features on both curved and reflective substrates and rapidly pattern large areas. A variety of materials could be patterned using the above techniques, including metals and polymers. The methods complement and extend existing nanolithographic techniques and provide new routes to high-quality patterns and structures with feature sizes of about 30 nm.

[0196] Standard lithography on silicone wafer or silica glass could also be used to fabricate the devices of the embodiments of this invention. Reservoirs, openings and channels in the micrometer or nanometer scale can be fabricated from the devices. If fluidic flow is employed, it can be controlled by pressure gradient, electrical field gradient, gravity, and/or heat gradient. The surfaces of the fluidic zones and/or the diffusion barriers can be modified with polymers (polyethylene glycol (PEG)-dramatized compounds) that can minimize non-specific binding. The solid support can be inorganic material (e.g., glass, ceramic) or metal (e.g., aluminum). Biomolecules, proteins, antibodies, and/or nucleic acids can be coated on the surface of the substrate for specific analyte binding.

[0197] In the embodiments of the invention, the channels formed on the substrate may be straight or have angles or curves along their lengths. The characteristics and layout of the channels are determined by the specific applications the device is designed for. Although straight channels lining next to one another are a typical design for microfluidic devices, the channels in the embodiments of the invention may be designed in many different patterns to serve specific separation and detection requirements. Specifically, the design of the channels takes into consideration of the microcoils associated with the fluidic zones such that one or more microcoils are capable of generating excitation magnetic fields across at least a portion of one fluidic zones. Further, in the embodiments of the invention, the cross-section of the fluidic zone so formed may be uniform or vary along the channel's length, and may have various shapes, such as rectangle, circle, or polygon.

EXAMPLES

Example 1

[0198] Magnetic Particles are Separated from Signal Particles in a Fluidic Device

[0199] A biochip was constructed as shown in FIG. **6**, containing a sample zone, a cleaning zone and a detection zone, which was functionally coupled to a magnet. A mixture of magnetic particles and Qdot particles was loaded into the sample zone. The arrows indicate the position of the magnetic particles over time, showing that they moved from the sample zone in panel **1** to the detection zone in panel **6**. UV fluorescence indicates that the Qdots were still located in the sample zone since no significant fluorescence was detected beyond the sample zone.

[0200] Solutions were retrieved from the sample zone and the detection zone, respectively, and finally adjusted to the same volumes for comparison. As a control, the same amount of particle mixture was cleaned in tubes; the supernatant from each step was saved to measure Qdot carry-over in the absence of analyte (see FIG. **6**B).

[0201] As shown by the control test in tubes (FIG. **6**C), Qdots were separated from magnetic particles after 4 washing steps; the same result could be achieved using the test chip; meaning the magnetic particles were free of Qdots after they were transported from the sample zone to the detection zone without liquid exchanges. In separate experiments, heterocomplex formation was demonstrated to be dependant on the amount of analyte molecules when the particles were conju-